Illinois Department of Transportation

Memorandum

To: ALL BRIDGE DESIGNERS 02.2

From: Ralph E. Anderson

Subject: Drilled Shaft Policy

Date: June 17, 2002

Ralph E. Anderson

Drilled shafts provide a viable and economical foundation solution in certain conditions. The Department has developed guidelines for appropriate applications of drilled shafts. The Guide Bridge Special Provision for Drilled Shafts (GBSP 2) was recently updated and six new base sheets have been developed which are included herein. The planner and designer should apply these resources on applicable projects. GBSP 2 and the English and metric versions of these new base sheets may be found on the IDOT web site.

Bridge planners must consider many issues in addition to design feasibility and construction costs before selecting drilled shafts as the most appropriate foundation support. Drilled shafts may be used to address vertical and lateral pile capacity concerns resulting from large scour depths, potential liquefaction, low soil strengths and inadequate pile embedment. Drilled shafts may also be used at sites indicating large variations in the top of rock elevations to avoid spread footing steps or construction changes in footing elevation. Concerns about pile driving vibration, noise or overhead clearance have also been reasons for specifying drilled shafts. In some locations they can also eliminate the need for cofferdams, seal coat and structure excavation.

A critical piece of information required for planning and construction of drilled shaft piers at stream crossings is the Estimated Water Surface Elevation (EWSE). This is the typical water surface elevation estimated to be prevailing at the time of construction, and is to be shown on the TSL Plans and Final Design Plans. Obviously, knowing when construction will actually take place and predicting the water surface elevation two or three years in advance of construction is a monumental if not impossible task. However, a "best effort" is necessary, and it should be recognized that the EWSE will at times be subject to many factors which could render it inaccurate. The attached base sheets contain a note, which allows for adjustment to the plans when the prevailing water surface is consistently different from the EWSE. The expectation is that if 50% of the drilled shaft projects can avoid the "adjustments" allowed, it will be an improvement over our current situation, which gives no direction to the contractor as to what water elevation may be expected.

Many bridge sites will be located in controlled pools, especially on major rivers, where the normal pool elevation established by the United States Corps of Engineers or other agencies will be readily available and serves as a very accurate water surface elevation. Other sites will be located at or near a United States Geological Survey stream gage station, which may be a source of data for estimating or verifying a typical water surface elevation. However, many sites will require an estimate based on hydraulic site surveys. In this case a standard method of finding the EWSE is presented in the attached sheet titled "Estimated Water Surface Elevation". This method is to be used only when better information/data is not available. A major assumption of any method, including the standard method, is that all construction will take place in the month of April, building some conservatism into the estimate.

The Bureau of Bridges & Structures Hydraulic Unit will record the stream site existing water surface elevation, date of survey and top of bank elevation in their Hydraulic Report review comments for all potential drilled shaft projects, for easy reference. It is recommended that this procedure also be followed on state owned bridges requiring a preliminary bridge design and hydraulic report prepared by others for local agencies.

The attached base sheets include various pier types and one for abutment details. Correct pier type selection is important to address constructability issues, and the following guidance is offered to assist in that selection:

- <u>Open Column Drilled Shaft Pier:</u> (Base Sheet P-DS) This substructure type typically provides the most economical shaft alternative where stream conditions permit. The top of the drilled shaft should be located 300 mm (1 ft) above the EWSE, which should be shown on the TSL and final plans. If aesthetics allow, permanent casing may be specified to simplify construction of the shaft through the water. If the appearance of permanent casing is undesirable, the length of the shaft where casing will not be allowed to remain in place shall be designated on the plans. For constructability reasons, that length should typically not exceed 3 m (10 ft). If the shaft extends through water deeper than 3 m (10 ft), permanent casing should be specified to make up the difference. Although this base sheet is detailed for a pier located in water where no permanent casing is permitted, permanent casing can be added or the base sheet modified for use at piers without concerns for water such as overbank piers or grade separations. As with any of the pier types, when permanent casing is necessary, the minimum limits should be shown on the plans and a separate pay item, Permanent Casing, should be added.

- <u>Column-Web Wall Drilled Shaft Pier</u>: (Base Sheet P-DSWW) Waterways with a history of debris collection or ice jams may necessitate the use of a web wall between the shafts. The need for this wall must be carefully evaluated and only used when conditions warrant since it adds cost and complexity to the project. The use of this pier type without a cofferdam is limited to locations where less than 1.8 m (6 ft) of water is expected at the shaft location. Construction of the web wall has been an issue in the past and thus the base sheet provides a construction sequence and a pay item "Underwater Structure Excavation Protection" for this work. Since the lower web wall is only connected to the upper web wall (not the shafts), the upper web wall should extend to 1.8 m (6 ft.) above the lower web wall or to the project's Design High Water Elevation whichever is higher. In cases where the top of the upper web wall is within 2.13 m (7 ft.) from the bottom of the pier cap, we recommend the upper web wall be extended to the bottom of cap.

- Encased Drilled Shaft Pier: (Base Sheet P-DSSW) This pier type may be used if dictated by watercraft traffic requiring a flush crash wall, or if an aesthetic requirement is needed to match the existing or new substructures, etc. The permanent casing will be covered by the encasement wall and thus is not an aesthetic concern. The drilled shaft diameter must be shown at least 300 mm (1 ft.) less than the encasement width to accommodate shaft construction tolerances. Since the encasement width limits the shaft diameter, more shafts are normally required, which causes this shaft supported pier type to be the most expensive. The use of this pier type without a cofferdam is limited to locations where less than 1.8 m (6 ft) of water is expected at the shaft location. This wall construction differs from the web walls in that the forms, reinforcement cage and concrete tremie pour completely surround the shafts and the upper encasement wall is poured monolithically with the column cage. The construction sequence of the encasement wall has been an issue in the past and thus the base sheet provides a construction sequence and a pay item "Underwater Structure Excavation Protection" for this work.

- Drilled Shaft Pier with Transfer Beam: (Base Sheet P-DSTB) This pier type is most suitable when the design loading (vessel impact, ice, seismic, etc.) requires more strength, stiffness, and redundancy along the axis of the pier. The transfer beam also provides additional construction tolerance to incorporate out of location shafts which are more likely in deep water shaft installations. Permanent casing can avoid the need for a cofferdam, provide a form through deeper water sites and add protection against stream abrasion. However, since the casings will remain below the beam, aesthetics and debris collection should be considered.

- Drilled Shaft Pier with Crash Wall: (Base Sheet P-DSCW) This pier type is normally used at grade separations where the proximity of the adjacent roadway or railroad traffic dictates the use of a crash wall. Since the crash wall is not acting as a footing, it can typically extend just 600 mm (2 ft) below the finished grade (similar to the abutment). The crash wall pier can also be used in locations requiring added strength, stiffness, and redundancy along the axis of the pier. In cases where the shaft diameter causes the crash wall width to increase excessively, a wider grade beam may be located below the thinner crash wall to connect it to the larger shafts.

- Abutment Drilled Shaft Details: (Base Sheet A-1-DSD) This base sheet may be used in conjunction with any of the above pier applications or to support single span structures. At sites where drilled shaft support is required at one abutment or at least half the substructure units, consideration should be given to using shafts at the remaining substructures to lower the unit shaft cost, when the cost advantage of using alternative foundation support is not significant.

Other issues related to the base sheets include:

- The spiral reinforcement in the shaft is shown at a 150 mm (6 in.) pitch to promote unrestricted flow of the concrete during the variety of difficult installation conditions present which could otherwise lead to construction defects. As such, the drilled shaft shall be designed as a column with ties (or hoops) spaced at 150 mm (6 in.) centers.

- The drilled shaft diameter is 150 mm (6 in.) larger in soil than in rock. However, they both use the same diameter reinforcement cage. This results in a 50 mm (2 in.) concrete cover for the reinforcement in rock and 125 mm (5 in.) of concrete cover for the reinforcement in soil. This ensures the proper rebar cover in soil regardless of the installation procedure and reduces the need for contractors to oversize the shaft in soil to drill the rock. At piers with columns directly above the shafts, the columns are detailed 150 mm (6 in.) smaller in diameter than the shafts to allow for construction tolerance in the shaft's plan location while enabling the designer to use the same diameter cage in the column and shaft.

WMK/bb23747

ESTIMATED WATER SURFACE ELEVATION
(EWSE)

Standard Estimating Method

1) From Hydraulic Report stream survey find the *existing water surface elevation*, as provided per Drainage Manual 2-601.2 & Fig. 2-601.2 b, (or low flow) at the bridge site and the month that this elevation was surveyed. Also, find the top of bank elevation from the stream cross sections at the bridge.
2) The *existing water surface elevation* is assumed to be a "typical low flow", in any year, for the month taken.
3) April is assumed to be the typical "high" month for water surface elevations and September is assumed to be the typical "low" month.
4) Using an equal monthly increment of 0.75', add or subtract from the *existing water surface elevation*, going from the month in step 1 to the month of construction (usually assumed to be April), within a calendar year. See example below.
5) The maximum elevation to be used is 75% of the difference from the typical September low flow elevation to the top of bank elevation added to the September low flow elevation.
6) The Estimated Water Surface Elevation is the lower elevation from step 4 or step 5.

Example

From Hydraulic Report stream cross section or profile: *Existing water surface elevation* = 606.1 at bridge site, date of survey is November 1999.

Nov.	Oct.	Sept.	Aug.	July	June	May	April	
606.1	-0.75	-0.75	+0.75	+0.75	+0.75	+0.75	+0.75	= 608.35

Check maximum: Top of bank elevation at bridge site is 611.3
Typical low flow for Sept. is 606.1 – 0.75 – 0.75 = 604.6
(611.3 – 604.6) x 0.75 + 604.6 = 609.6 ; 609.6 > 608.35

Therefore EWSE = 608.35

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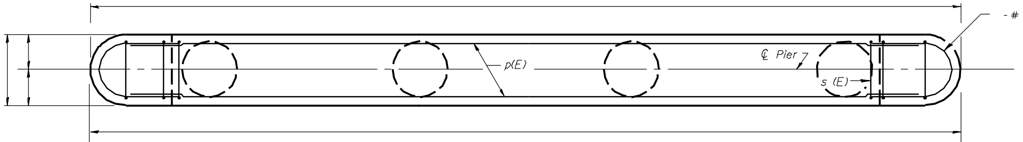
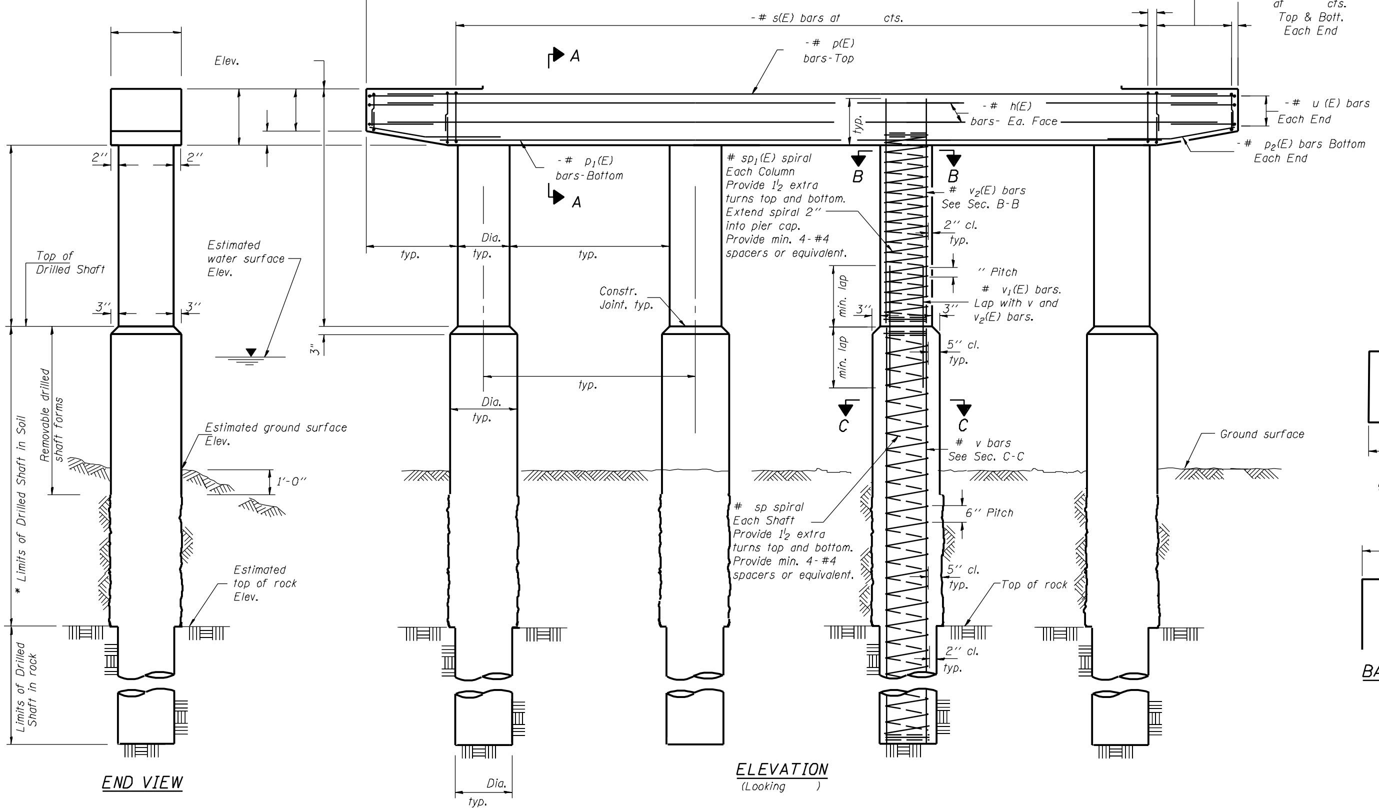
SHEET NO. -	- SHEETS

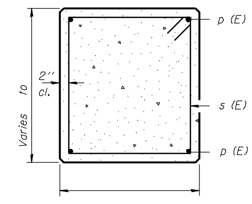


TOP PLAN



END VIEW

ELEVATION
(Looking)



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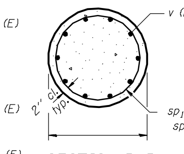

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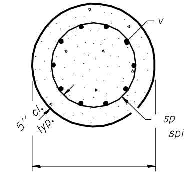

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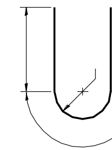
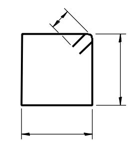
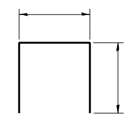


BAR u(E)



BAR s(E)



BAR s_1(E)

BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
p(E)		#		
p_1(E)		#		
p_2(E)		#		
s(E)		#		
s_1(E)		#		
** sp		#		
** sp_1(E)		#		
u(E)		#		
v		#		
v_1(E)		#		
v_2(E)		#		
Drilled Shaft in Soil '' Dia.			Foot	
Drilled Shaft in Rock '' Dia.			Foot	
Concrete Structures			Cu. Yd.	
Reinforcement Bars, Epoxy Coated			Pound	
Reinforcement Bars			Pounds	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = 1 ½ turns.
**Length is height of spiral.

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

- 20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

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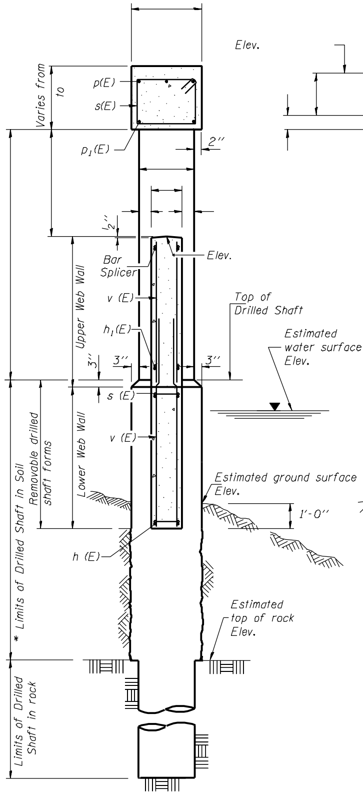
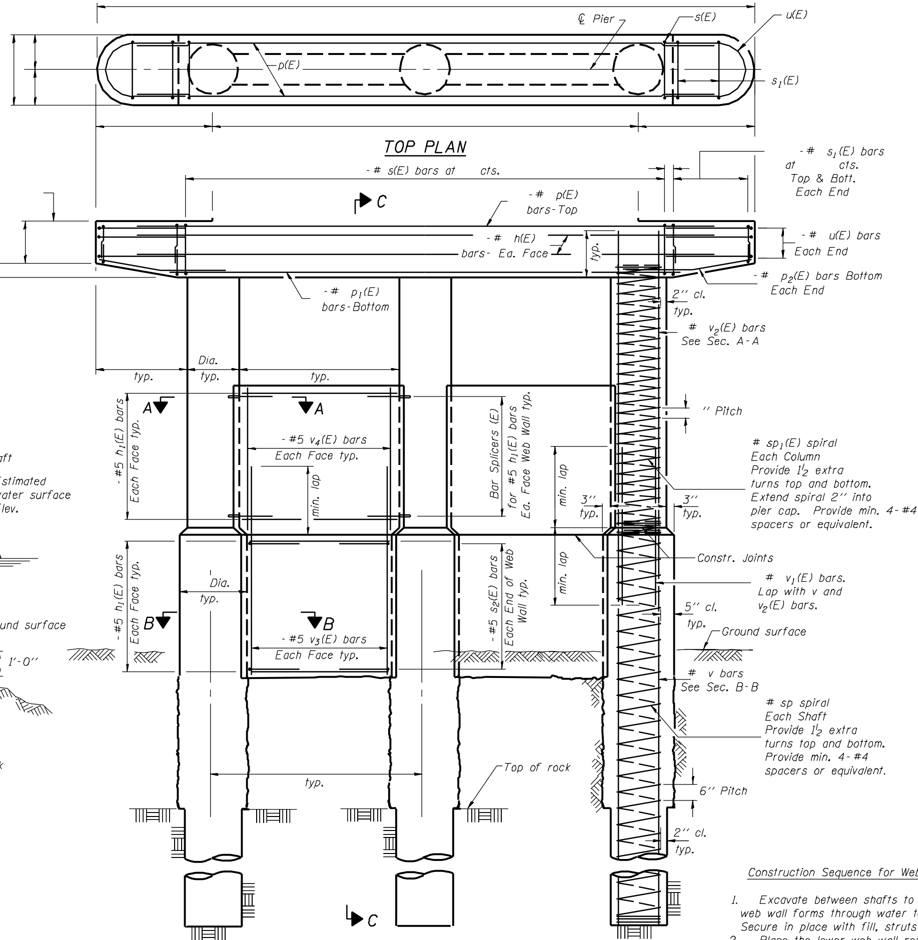
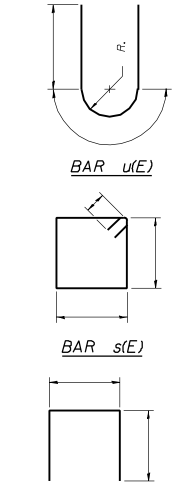
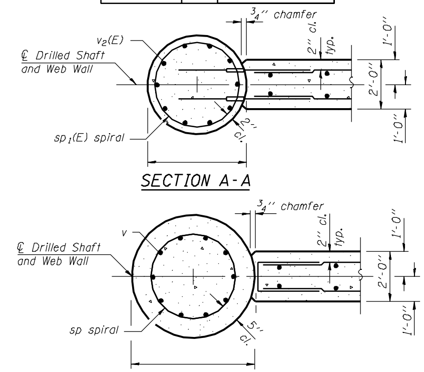
DEPARTMENT OF TRANSPORTATION

SHEET NO. -
- SHEETS









BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
h_1(E)		#		
p(E)		#		
p_1(E)		#		
p_2(E)		#		
s(E)		#		
s_1(E)		#		
s_2(E)		#		
** sp		#		
** sp_1(E)		#		
u(E)		#		
v		#		
v_1(E)		#		
v_2(E)		#		
v_3(E)		#		
v_4(E)		#		
Underwater Structure Excavation Protection Location			Each	
Drilled Shaft in Soil '' Dia.			Foot	
Drilled Shaft in Rock '' Dia.			Foot	
Concrete Structures			Cu. Yd.	
Reinforcement Bars, Epoxy Coated			Pound	
Reinforcement Bars			Pound	
Bar Splicers			Each	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = $1\frac{1}{2}$ turns.
**Length is height of spiral.

Construction Sequence for Web Wall:

1. Excavate between shafts to elevation of web wall base and set lower web wall forms through water to bear on the circular edge of drilled shafts. Secure in place with fill, struts or tie forms together as required.
2. Place the lower web wall reinforcement cage into the forms using spacers to maintain proper clearances.
3. If the forms can be sealed against the shafts and streambed to allow dewatering, the reinforcement and the concrete placement may be completed in the dry. Alternatively, the rebar cage can be lowered into position through water and the concrete discharged at the base of the excavation through a tremie pipe or pump hose, displacing water, sediment, and tainted concrete out the top of the forms.
4. Construct Columns.
5. Construct upper web walls.

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

DESIGNED -	
CHECKED -	
DRAWN -	
CHECKED -	

- 20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

P-DSWW

*** Contractor is responsible for determining the casing thickness and the actual tip elevation to be used (see Special Provisions).
Pay limits for the Permanent Casing are based on the minimum length shown.

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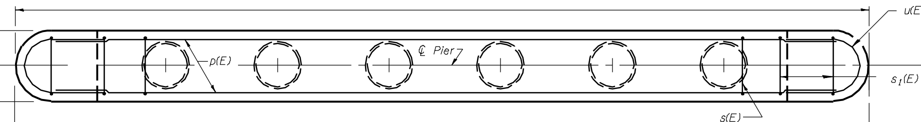
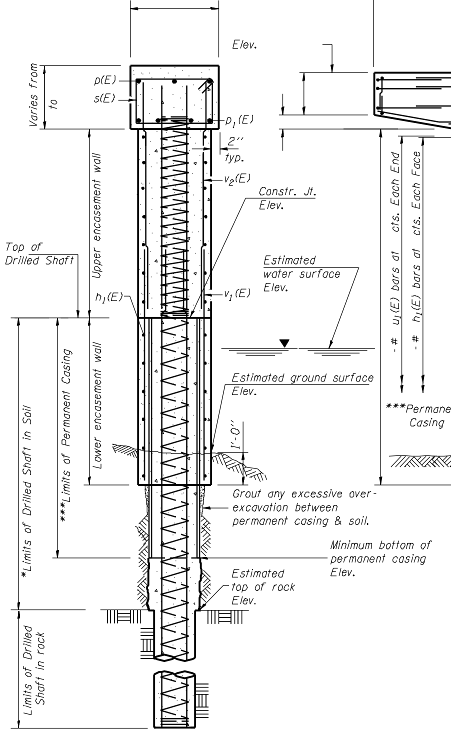
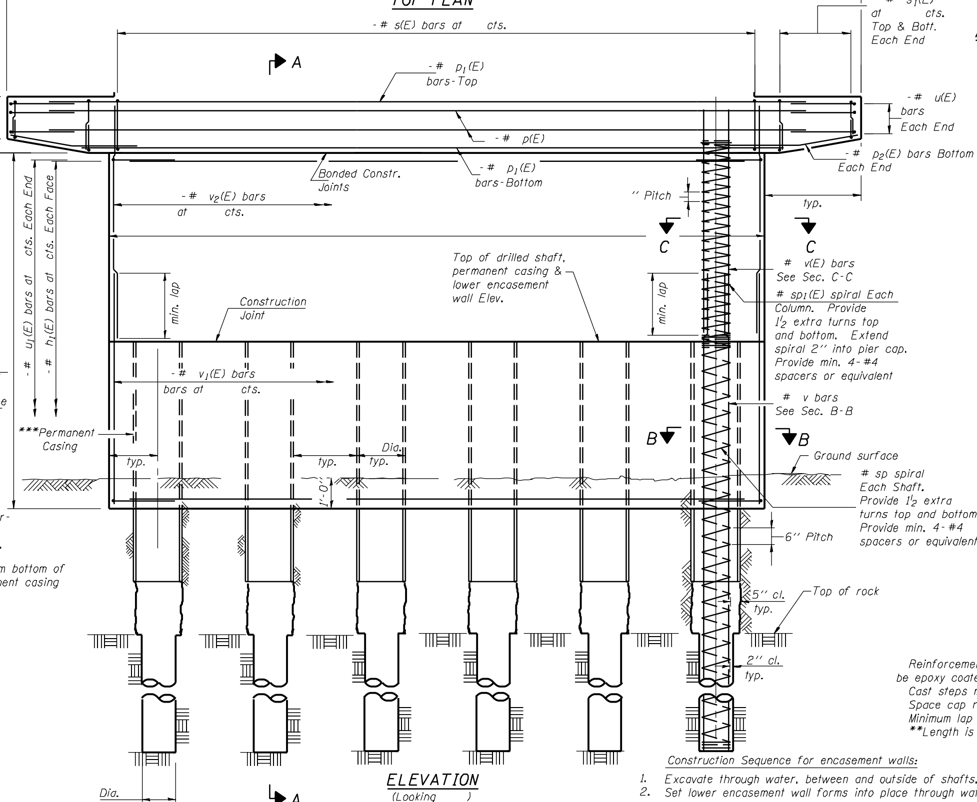


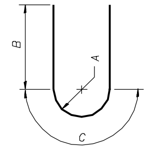
TOP PLAN



SECTION A-A



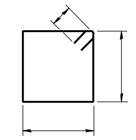
ELEVATION
(Looking)



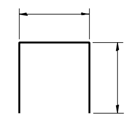
BAR u(E) or u1(E)

A, B & C DIMENSIONS

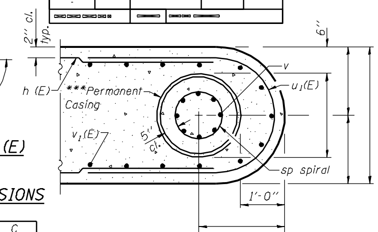
Bar	A	B	C
u(E)			
u1(E)			



BAR s(E)



BARS s1(E)



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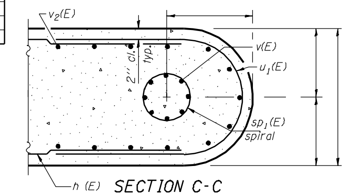

SECTION C-C

BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
h1(E)		#		
p(E)		#		
p1(E)		#		
p2(E)		#		
s(E)		#		
s1(E)		#		
** sp		#		
** sp1(E)		#		
u(E)		#		
u1(E)		#		
v		#		
v(E)		#		
v1(E)		#		
v2(E)		#		
Underwater Structure Excavation Protection, Location			Each	
Drilled Shaft in Soil '' Dia.			Foot	
Drilled Shaft in Rock '' Dia.			Foot	
Concrete Structures			Cu. Yd.	
Reinforcement Bars, Epoxy Coated			Pound	
Reinforcement Bars			Pound	
Permanent Casing			Foot	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = 1 ½ turns.
**Length is height of spiral.

Construction Sequence for encasement walls:

1. Excavate through water, between and outside of shafts, to base of lower encasement wall.
2. Set lower encasement wall forms into place through water and secure at top and bottom as required to maintain proper clearance from shaft.
3. Place the lower encasement wall reinforcement cage into forms using spacers to maintain proper clearances from shaft and forms.
4. If the forms can be sealed against the streambed to allow dewatering, the reinforcement and the concrete placement may be completed in the dry. Alternatively, the rebar cage can be lowered into position through water and the concrete discharged at the base of the excavation through a tremie pipe or pump hose, displacing water, sediment, and tainted concrete out the top of the forms.
5. Prepare construction joint at top of drilled shafts and lower encasement wall.
6. Splice upper encasement wall reinforcement and cage length to lower encasement and shaft reinforcement, form and pour upper encasement wall.

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

DESIGNED -	- 20
CHECKED -	EXAMINED
	ENGINEER OF BRIDGE DESIGN
DRAWN -	PASSED
	ENGINEER OF BRIDGES AND STRUCTURES
CHECKED -	

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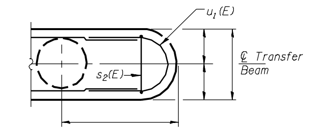
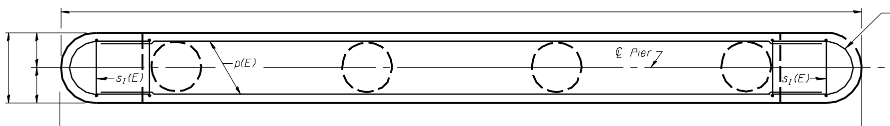
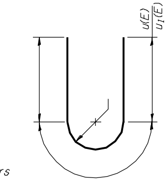


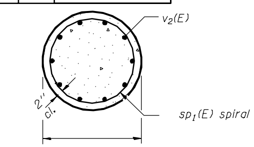
SECTION D-D



TOP PLAN



BARS u(E) and $u_1(E)$



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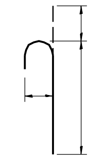
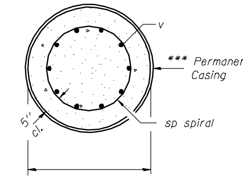
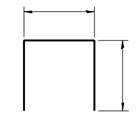


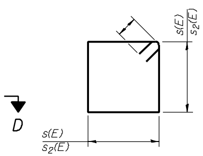
BAR n(E)



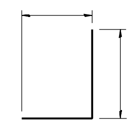
SECTION B-B



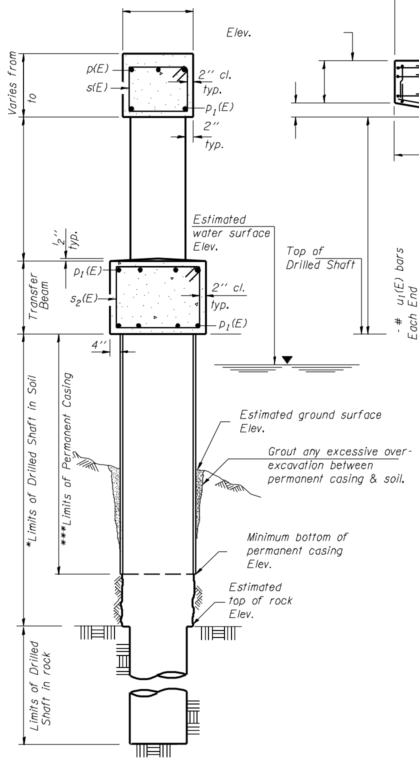
BAR $s_1(E)$



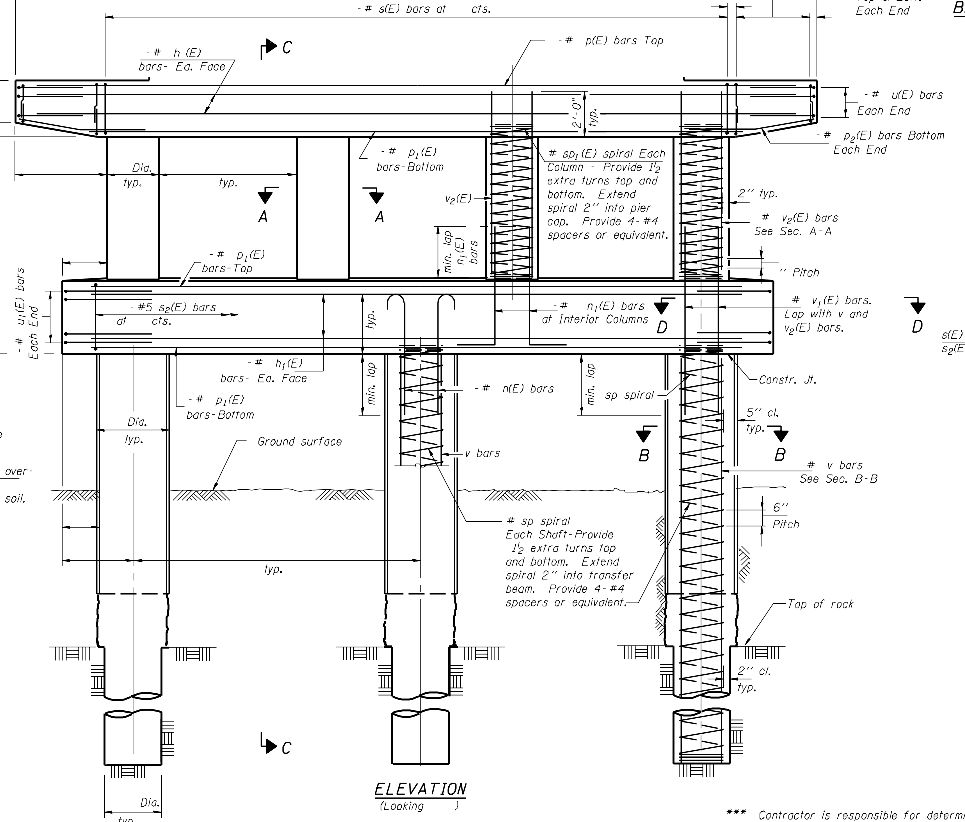
BARS s(E) & $s_2(E)$



BAR $n_1(E)$



SECTION C-C



ELEVATION
(Looking)

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

*** Contractor is responsible for determining the casing thickness and the actual tip elevation to be used (see Special Provisions).
Pay limits for the Permanent Casing shall be based on the minimum length shown.

BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		—
$h_1(E)$		#		—
n(E)		#		
$n_1(E)$		#		
p(E)		#		—
$p_1(E)$		#		—
$p_2(E)$		#		
s(E)		#		
$s_1(E)$		#		
$s_2(E)$		#		
** sp		#		
** $sp_1(E)$		#		
u(E)		#		
$u_1(E)$		#		
v		#		—
$v_1(E)$		#		—
$v_2(E)$		#		—
Permanent Casing			Foot	
Drilled Shaft in Soil '' Dia.			Foot	
Drilled Shaft in Rock '' Dia.			Foot	
Concrete Structures			Cu. Yd.	
Reinforcement Bars, Epoxy Coated			Pound	
Reinforcement Bars			Pound	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = $1\frac{1}{2}$ turns.
**Length is height of spiral.

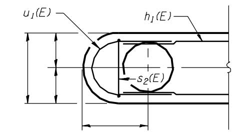
DESIGNED -	
CHECKED -	
DRAWN -	
CHECKED -	

- 20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

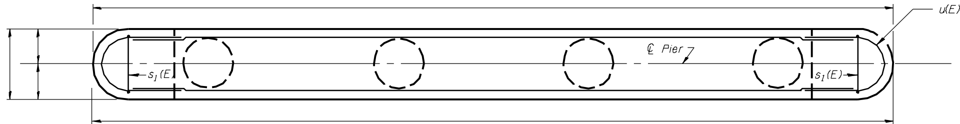
P-DSTB

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

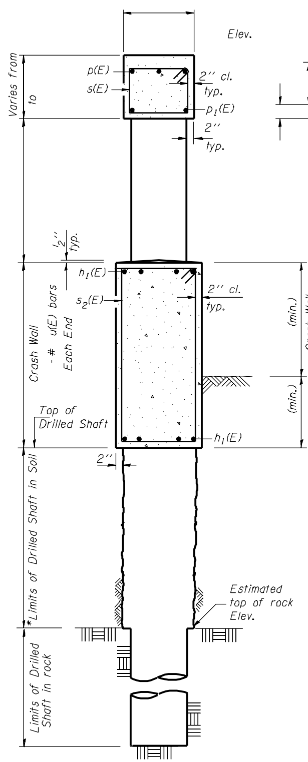
					SHEET NO. -
-	-	-			- SHEETS



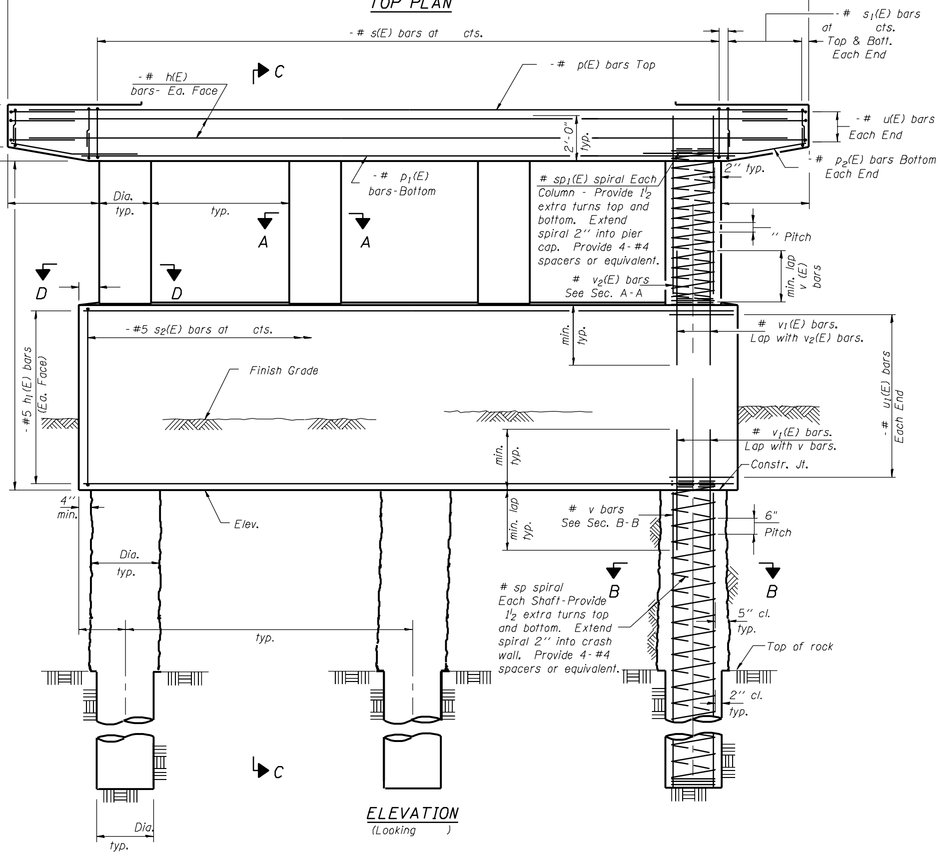
SECTION D-D



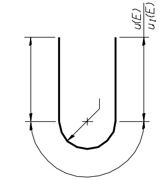
TOP PLAN



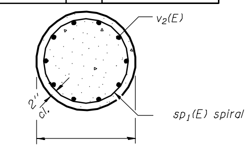
SECTION C-C



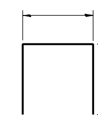
ELEVATION
(Looking)



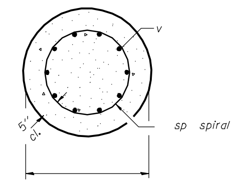
BARS u(E) and $u_1(E)$



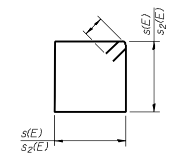
SECTION A-A



BAR $s_1(E)$



SECTION B-B



BARS s(E) & $s_2(E)$

BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
$h_1(E)$		#		
p(E)		#		
$p_1(E)$		#		
$p_2(E)$		#		
s(E)		#		
$s_1(E)$		#		
$s_2(E)$		#5		
** sp		#		
** $sp_1(E)$		#		
u(E)		#		
$u_1(E)$		#		
v		#		
$v_1(E)$		#		
$v_2(E)$		#		
Drilled Shaft in Soil '' Dia.			Foot	
Drilled Shaft in Rock '' Dia.			Foot	
Concrete Structures			Cu. Yd.	
Reinforcement Bars, Epoxy Coated			Pound	
Reinforcement Bars			Pound	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = $1\frac{1}{2}$ turns.
**Length is height of spiral.

* The quantities and reinforcement detailing are based on the top of shaft and the estimated top of rock elevations shown and may change based on the actual top of rock encountered at each shaft and the final top of shaft elevation.

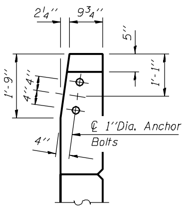
DESIGNED -	
CHECKED -	
DRAWN -	
CHECKED -	

\- 20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

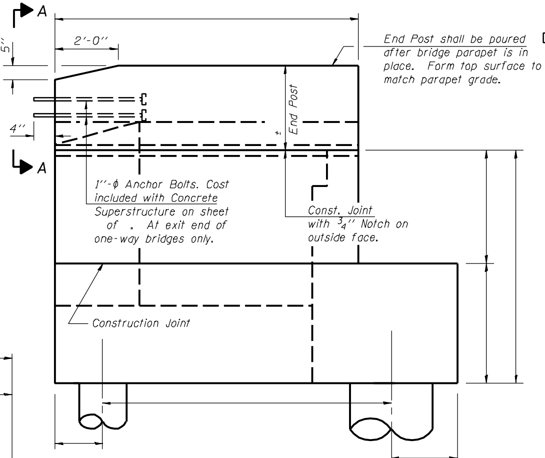
P-DSCW

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

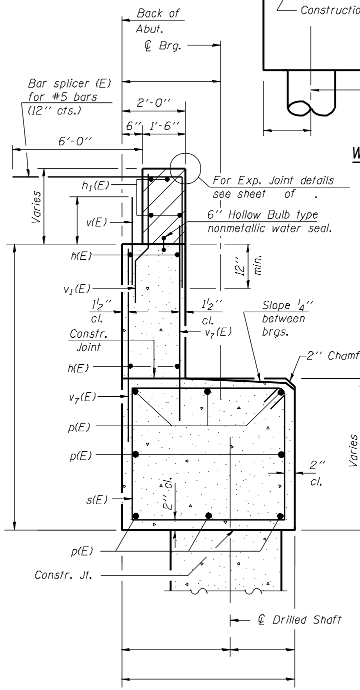
					SHEET NO. -
-	-	-			- SHEETS



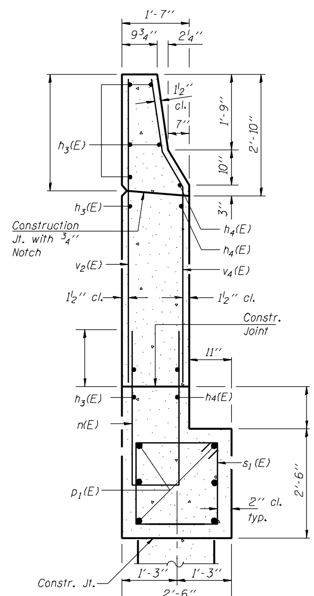
VIEW A-A



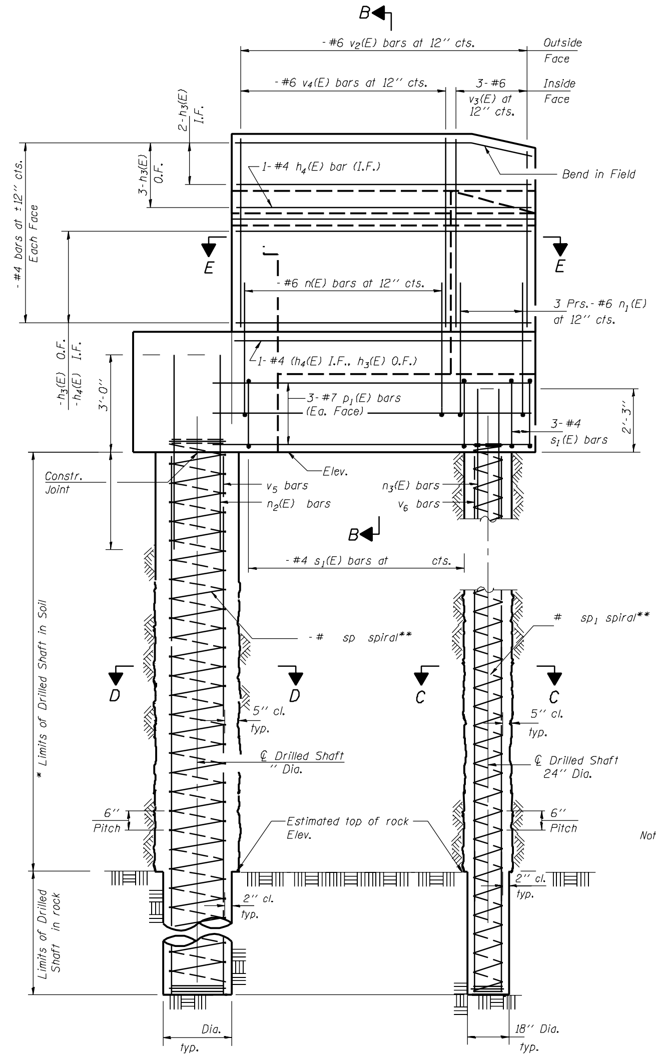
WING WALL ELEVATION
Showing Dimensions



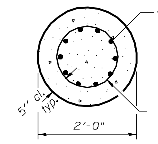
SECTION THRU ABUTMENT



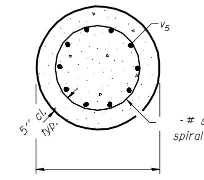
SECTION B-B



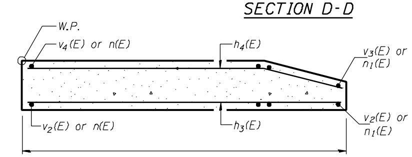
WING WALL & DRILLED SHAFT ELEVATION
Showing Reinforcement



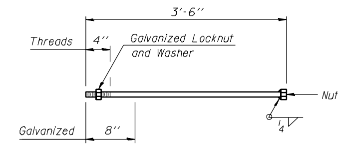
SECTION C-C



SECTION D-D



SECTION E-E



1″ ϕ ANCHOR BOLT

Notes: * The quantities and detailing are based on the estimated elevations shown on the plans. The actual elevations may differ at each shaft and corresponding adjustments shall be made to the drilled shaft and reinforcement quantities and payment limits.
Reinforcement bars designated (E) shall be epoxy coated.
Quantity of concrete in end post included with Concrete Superstructure on sheet of .
** Provide 1½ extra turns top and bottom of each drilled shaft. Extend spiral 2″ into abutment or wingwall cap. Provide min. 4- #4 spacers or equivalent.

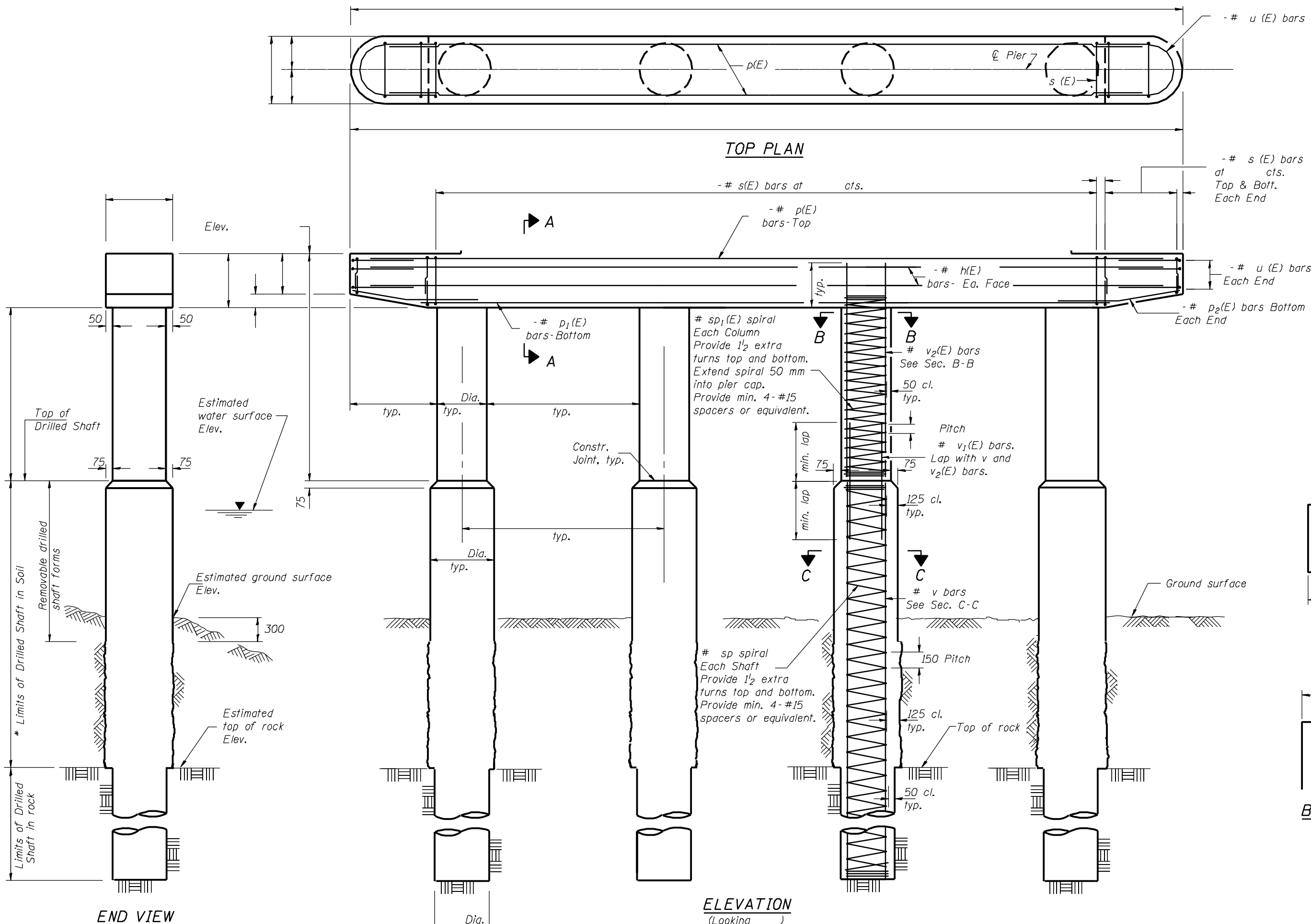
DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

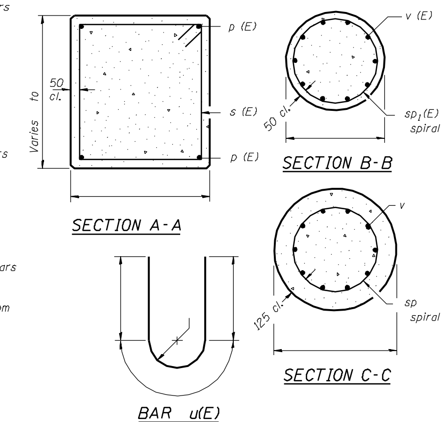
- 20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

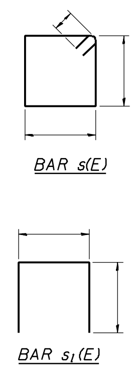
A-1-DSD

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. -
- SHEETS







BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
p(E)		#		
$p_1(E)$		#		
$p_2(E)$		#		
s(E)		#		
$s_1(E)$		#		
** sp		#		
** $sp_1(E)$		#		
u(E)		#		
v		#		
$v_1(E)$		#		
$v_2(E)$		#		
Drilled Shaft in Soil mm Dia.		m		
Drilled Shaft in Rock mm Dia.		m		
Concrete Structures		m^3		
Reinforcement Bars, Epoxy Coated		kg		
Reinforcement Bars		kg		

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = 1 ½ turns.
**Length is height of spiral.
All dimensions are in millimeters (mm) except as noted.

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

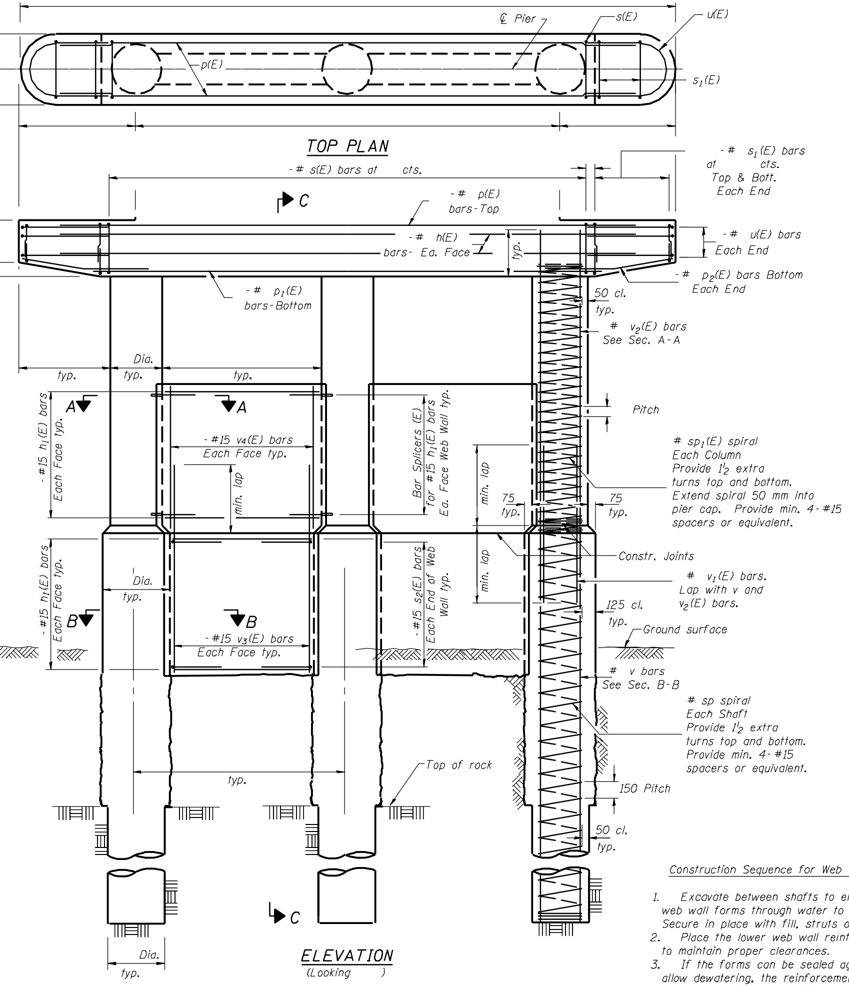
DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

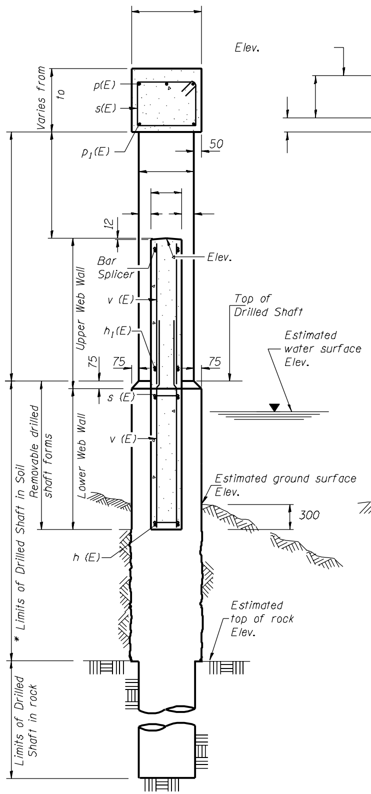
20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

P-DS (M)

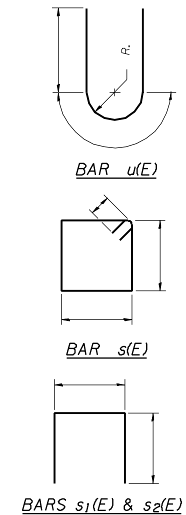
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

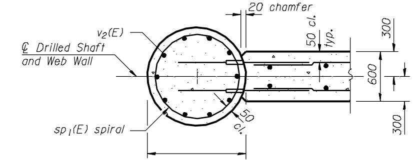
					SHEET NO. -
-	-	-			- SHEETS



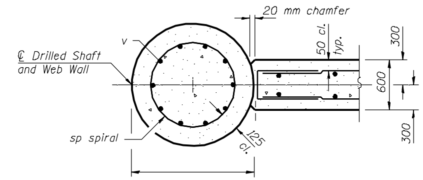


SECTION C-C





SECTION A-A



SECTION B-B

BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
h1(E)		#		
p(E)		#		
p1(E)		#		
p2(E)		#		
s(E)		#		
s1(E)		#		
s2(E)		#		
** sp		#		
** sp1(E)		#		
u(E)		#		
v		#		
v1(E)		#		
v2(E)		#		
v3(E)		#		
v4(E)		#		
Underwater Structure Excavation Protection Location		Each		
Drilled Shaft in Soil mm Dia.		m		
Drilled Shaft in Rock mm Dia.		m		
Concrete Structures		m^3		
Reinforcement Bars, Epoxy Coated		kg		
Reinforcement Bars		kg		
Bar Splicers		Each		

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = 1 ½ turns.
**Length is height of spiral.
All dimensions are in millimeters (mm) except as noted.

Construction Sequence for Web Wall:

1. Excavate between shafts to elevation of web wall base and set lower web wall forms through water to bear on the circular edge of drilled shafts. Secure in place with fill, struts or tie forms together as required.
2. Place the lower web wall reinforcement cage into the forms using spacers to maintain proper clearances.
3. If the forms can be sealed against the shafts and streambed to allow dewatering, the reinforcement and the concrete placement may be completed in the dry. Alternatively, the rebar cage can be lowered into position through water and the concrete discharged at the base of the excavation through a tremie pipe or pump hose, displacing water, sediment, and tainted concrete out the top of the forms.
4. Construct Columns.
5. Construct upper web walls.

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

P-DSWW (M)

					SHEET NO. -
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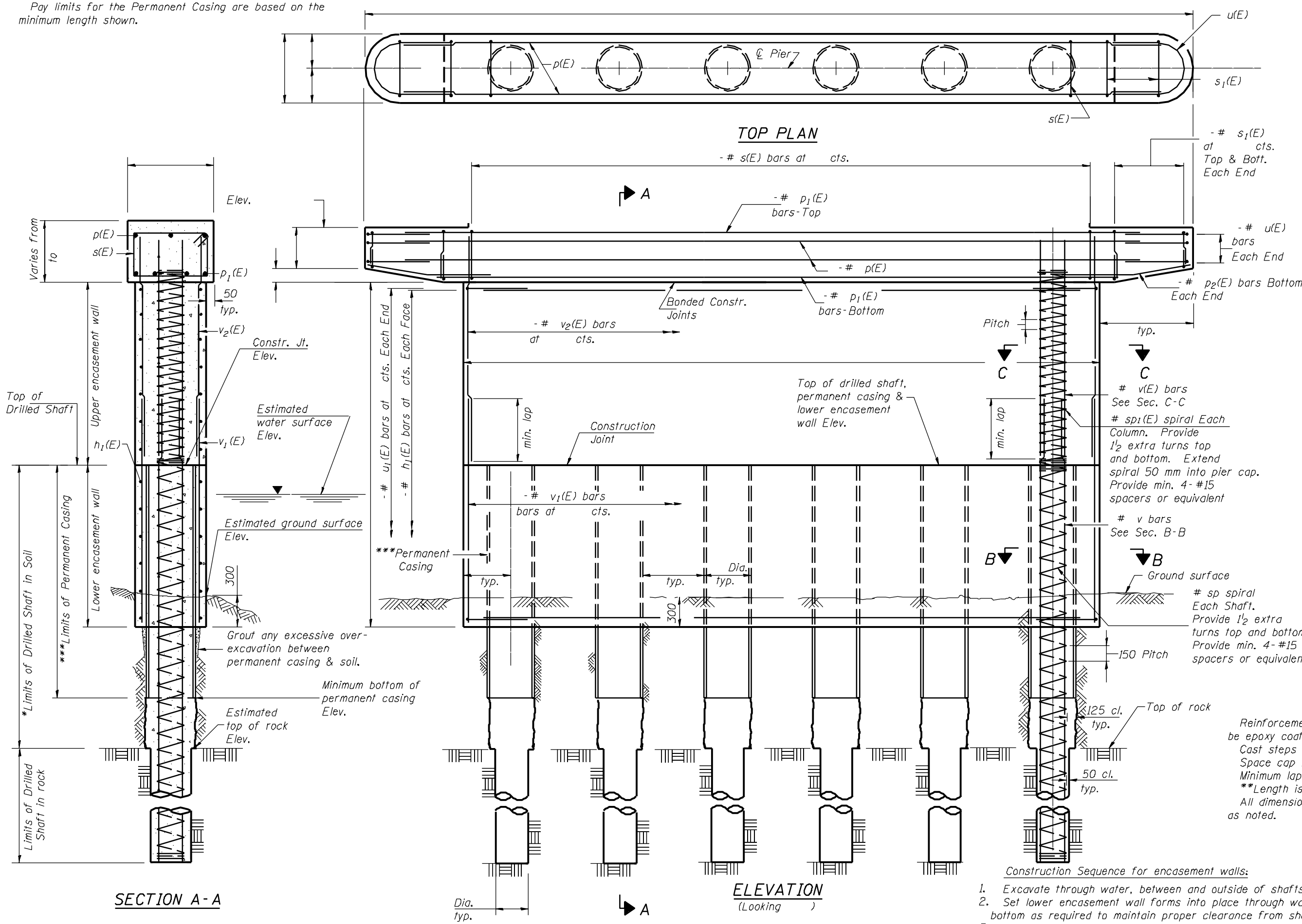
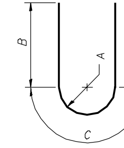
*** Contractor is responsible for determining the casing thickness and the actual tip elevation to be used (see Special Provisions).
Pay limits for the Permanent Casing are based on the minimum length shown.

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

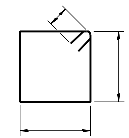




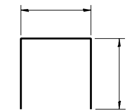
BAR u(E) or $u_1(E)$

A, B & C DIMENSIONS

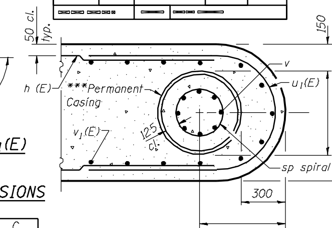
Bar	A	B	C
u(E)			
$u_1(E)$			



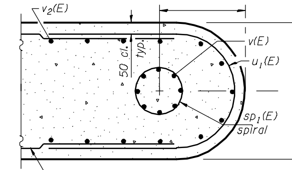
BAR s(E)



BARS $s_1(E)$



SECTION B-B



SECTION C-C

BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
$h_1(E)$		#		
p(E)		#		
$p_1(E)$		#		
$p_2(E)$		#		
s(E)		#		
$s_1(E)$		#		
** sp		#		
** $sp_1(E)$		#		
u(E)		#		
$u_1(E)$		#		
v		#		
v(E)		#		
$v_1(E)$		#		
$v_2(E)$		#		
Underwater Structure Excavation Protection, Location			Each	
Drilled Shaft in Soil mm Dia.			m	
Drilled Shaft in Rock mm Dia.			m	
Concrete Structures			m^3	
Reinforcement Bars, Epoxy Coated			kg	
Reinforcement Bars			kg	
Permanent Casing			m	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = $1\frac{1}{2}$ turns.
**Length is height of spiral.
All dimensions are in millimeters (mm) except as noted.

Construction Sequence for encasement walls:

1. Excavate through water, between and outside of shafts, to base of lower encasement wall.
2. Set lower encasement wall forms into place through water and secure at top and bottom as required to maintain proper clearance from shaft.
3. Place the lower encasement wall reinforcement cage into forms using spacers to maintain proper clearances from shaft and forms.
4. If the forms can be sealed against the streambed to allow dewatering, the reinforcement and the concrete placement may be completed in the dry. Alternatively, the rebar cage can be lowered into position through water and the concrete discharged at the base of the excavation through a tremie pipe or pump hose, displacing water, sediment, and tainted concrete out the top of the forms.
5. Prepare construction joint at top of drilled shafts and lower encasement wall.
6. Splice upper encasement wall reinforcement and cage length to lower encasement and shaft reinforcement, form and pour upper encasement wall.

* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

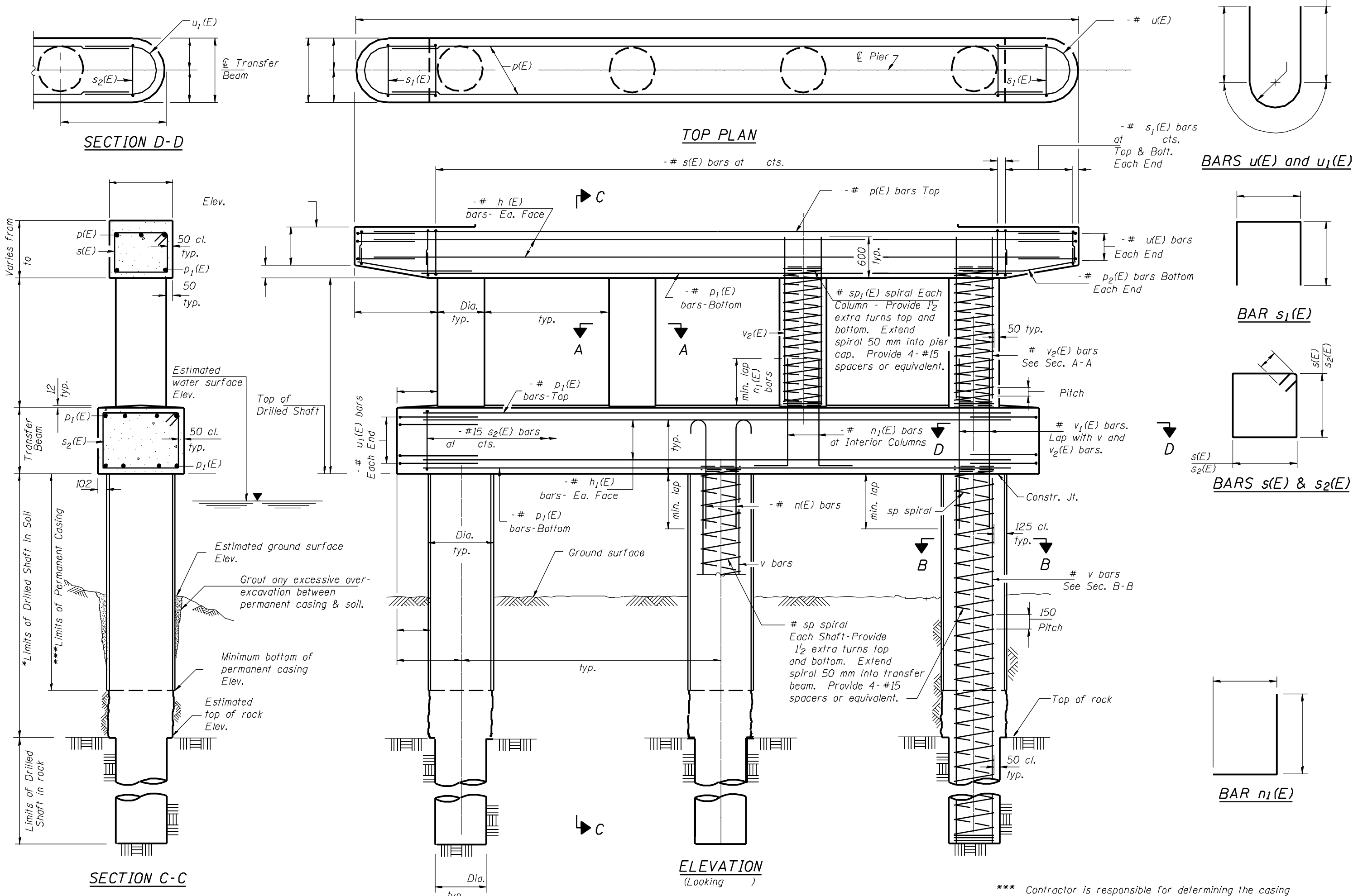
DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

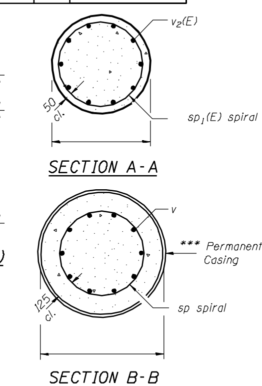
20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

P-DSSW (M)

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

					SHEET NO. -
	-	-			- SHEETS





BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
h1(E)		#		
n(E)		#		
n1(E)		#		
p(E)		#		
p1(E)		#		
p2(E)		#		
s(E)		#		
s1(E)		#		
s2(E)		#		
** sp		#		
** sp1(E)		#		
u(E)		#		
u1(E)		#		
v		#		
v1(E)		#		
v2(E)		#		
Permanent Casing		m		
Drilled Shaft in Soil mm Dia.		m		
Drilled Shaft in Rock mm Dia.		m		
Concrete Structures		m^3		
Reinforcement Bars, Epoxy Coated		kg		
Reinforcement Bars		kg		

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = 1 ½ turns.
**Length is height of spiral.
All dimensions are in millimeters (mm) except as noted.

*** Contractor is responsible for determining the casing thickness and the actual tip elevation to be used (see Special Provisions). Pay limits for the Permanent Casing shall be based on the minimum length shown.

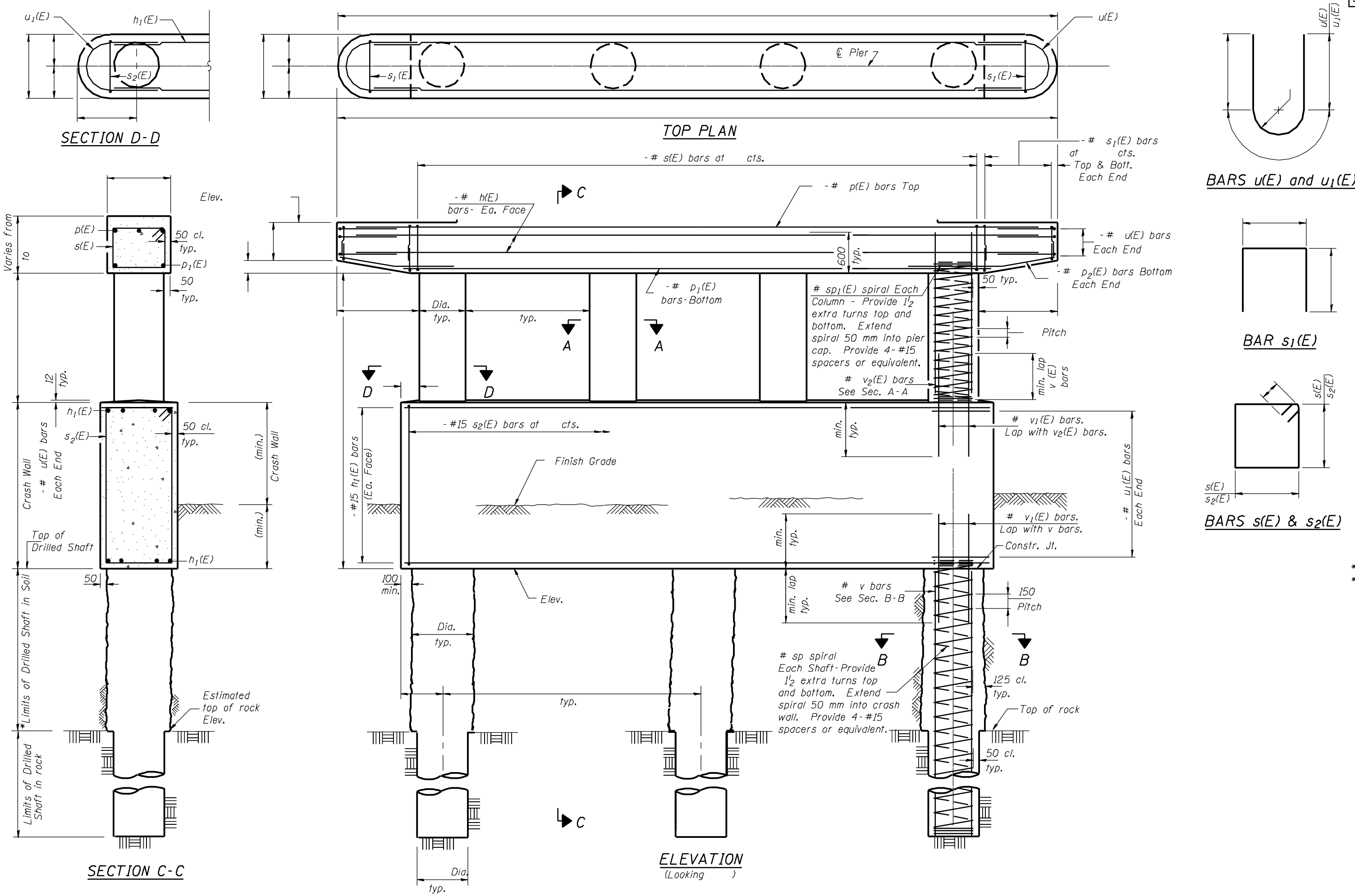
* If the prevailing water surface elevation during construction is consistently different than estimated on the plans, the contractor may propose an adjustment to the top of the drilled shaft elevation as part of their installation procedure. The top of all drilled shafts within a substructure unit shall be constructed to the same elevation and extend above the prevailing water surface. The quantities and reinforcement detailing are based on the top of shaft and the estimated elevations shown and may change based on the actual elevations encountered at each shaft and the final top of shaft elevation.

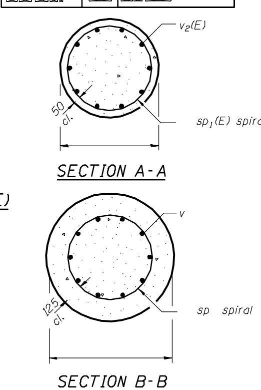
DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

EXAMINED 20
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

P-DSTB (M)

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION





BILL OF MATERIAL

Bar	No.	Size	Length	Shape
h(E)		#		
$h_1(E)$		#		
p(E)		#		
$p_1(E)$		#		
$p_2(E)$		#		
s(E)		#		
$s_1(E)$		#		
$s_2(E)$		#15		
** sp		#		
** $sp_1(E)$		#		
u(E)		#		
$u_1(E)$		#		
v		#		
$v_1(E)$		#		
$v_2(E)$		#		
Drilled Shaft in Soil mm Dia.			m	
Drilled Shaft in Rock mm Dia.			m	
Concrete Structures			m^3	
Reinforcement Bars, Epoxy Coated			kg	
Reinforcement Bars			kg	

Reinforcement Bars designated (E) shall be epoxy coated.
Cast steps monolithically with cap.
Space cap reinforcement to miss anchor bolts.
Minimum lap for spirals = 1 ½ turns.
**Length is height of spiral.
All dimensions are in millimeters (mm) except as noted.

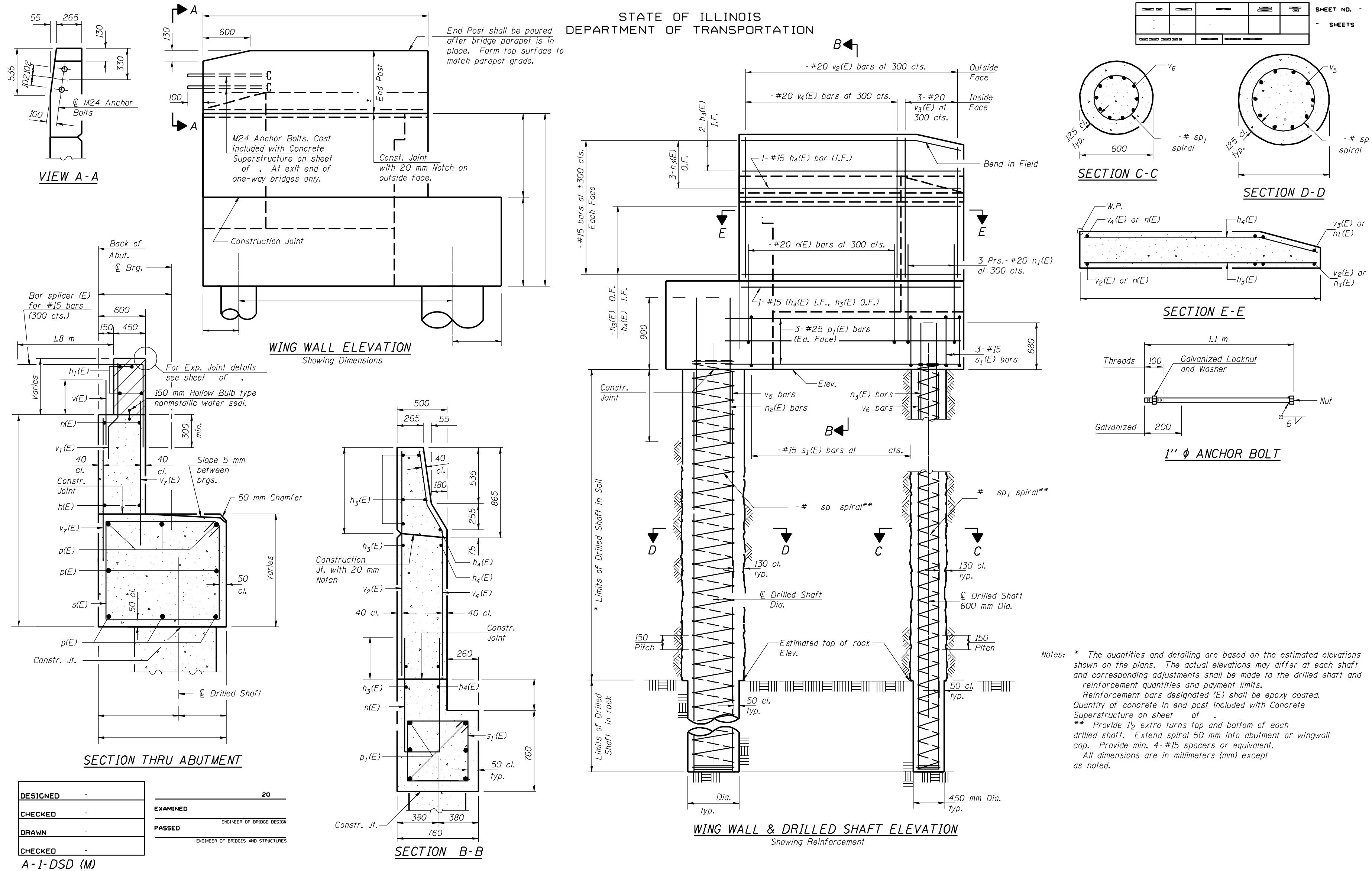
* The quantities and reinforcement detailing are based on the top of shaft and the estimated top of rock elevations shown and may change based on the actual top of rock encountered at each shaft and the final top of shaft elevation.

DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

P-DSCW (M)

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION



Notes: * The quantities and detailing are based on the estimated elevations shown on the plans. The actual elevations may differ at each shaft and corresponding adjustments shall be made to the drilled shaft and reinforcement quantities and payment limits.
Reinforcement bars designated (E) shall be epoxy coated.
Quantity of concrete in end post included with Concrete Superstructure on sheet of .
** Provide 1½ extra turns top and bottom of each drilled shaft. Extend spiral 50 mm into abutment or wingwall cap. Provide min. 4-#15 spacers or equivalent.
All dimensions are in millimeters (mm) except as noted.

DESIGNED	-
CHECKED	-
DRAWN	-
CHECKED	-

20
EXAMINED
ENGINEER OF BRIDGE DESIGN
PASSED
ENGINEER OF BRIDGES AND STRUCTURES

SHEET NO. -
- SHEETS

A-1-DSD (M)